IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s): Lee	
Application No.: 10/564,895	Art Unit: 2128
Filed: 1/17/2006	
Title: Improved 3D Velocity Modeling, with Calibration and Trend Fitting using Geostatistical Techniques, Particularly Advantageous for Curved-Ray Prestack T	Examiner: Phan, Thai
Attorney Docket No.: 50243	

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

RESPONSE TO OFFICE ACTION
Mailed 4-1-08

Dear Sir:

REMARKS

Applicant respectfully traverses the rejection of claims 1-35 under §102 as anticipated by Jones, US Patent No. 5, 838,634.

Applicant's independent claims are claims 1, 2, 22, 25, 28 and 33.

PRELIMINARY MATTERS

All claims 1-35 are listed as rejected as anticipated by Jones. The Examiner specifically addresses only claims 1-16. Claims 17-35 are rejected "in like manner" due to their "similarity" to claims 1-16. Applicant therefore traverses the rejection of claim 17-35 in like manner, for at least the same reasons given for traversing the rejections of claims 1-16.

In regard to claims 3 and 6 – 15, it is not specifically asserted that Jones even anticipates these claims, and no cite to any portion of Jones is offered supporting anticipation. Thus, applicant submits that no prima facie case has been made with respect to claims 3 and 6-15 and that these claims are allowable.

In re claim 5, the Examiner asserts that Jones anticipates claim 5 but, again, no cite to any portion of Jones is given as support. Applicant submits therefore that no prima facie case has been made in regard to claim 5, also, and that claim 5 is allowable without more.

THE INDEPENDENT CLAIMS

Seismic data acquired at the surface of the earth provides non-unique solutions. Incorporating well data into or with such seismic data, assuming proper procedures for incorporation, can help produce better "least wrong" solutions as well as more geologically accurate solutions. The instant invention is directed to providing more geologically accurate RMS velocity trends and seismic images, including

stacked and migrated traces. Reviewing the instant application and the Jones patent in context, it is clear that the Jones patent picks up where the instant application leaves off. The instant application provides more geologically accurate seismic traces and velocity trends which are tied to hidden stratigraphic trends. The Jones patent uses such seismic data output from programs analogous to the instant program to provide more geologically meaningful rock properties, through repeated seismic inversions.

Claim Element - "Trend Fitting" or "Interpolation as a Function of Lateral Trends Derived from Seismic Data"

Interpolation (e.g., of scale factors and/or of RMS velocities) as a function of lateral trends based on seismic data, or "trend fitting" using variogram modeling based on seismic data (or similar words,) is an element of every independent claim.

E.g. claim 1, in elements d and e, recites interpolation as a function of "lateral trends." The "lateral trends" are "of RMS velocities derived from seismic data by geostatistical variogram modeling."

Claim 2 recites, in element c, "trend fitting" using "the" variogram modeling ("iDEPTHing;") prior steps recite constructing a velocity model from seismic data and variogram modeling of interval velocities.

Claim 22 recites "geostatistically interpolated" velocity function values, or values that are a function of the geostatistical interpolation of velocity functions, as well as the geostatistical interpolation of a scale factor; the geostatistical interpolations are a function of lateral velocity trends developed from seismic data.

Claim 25 recites developing a variogram model of lateral velocity trends from seismic data and geostatistically interpolating, where the geostatistical interpolations are a function of the variogram model."

Claim 28 recites generating "lateral velocity trends" from the seismic data and the interpolation of scale factors and calibrated velocity functions being a function of the lateral velocity trends."

Claim 33 recites developing a "trend fitted" RMS velocity model from seismic data and hard (well) data and developing a "trend fitted" interval velocity model.

Applicant respectfully submits that Jones '634 neither teaches nor suggests computing "lateral trends" by geostatistical variogram modeling of seismic data, and/or interpolation as a function of the lateral trends, or geostatistically interpolating as a function of a variogram model of lateral velocity trends derived from seismic data. The Examiner identifies no such teaching in Jones. See discussion below. Thus, all independent claims, and those that depend therefrom, are allowable without more.

Jones does not teach "trend fitting" seismic data- Contrary to Examiner's Assertions re claims 1 and 2

In regard to the elements of claim 1 reciting computing lateral trends by geostatistical variogram modeling of seismic data and interpolation as a function of the trends, the Examiner cites Jones column 3

lines 25-34, and column 11 line 54 to column 12 line 9, and columns 14-16, for anticipatory teaching. These cites in Jones do not so teach.

In regard to claim 2, as a whole, including "trend fitting" as above, the Examiner cites Jones columns 16-19. These cites do not teach variogram modeling of seismic data.

<u>Claim 1</u>

<u>First, re claim 1,</u> the Examiner cites Jones column 3 lines 25-34; column 11 line 54; column 12 line 9; and columns 14 - 16 for the element of trend fitting, developing a variogram model of lateral velocity trends from the seismic data. Review of the cites, below, shows that nowhere in the cites does Jones teach, explicitly, implicitly or inherently, "trend fitting" <u>based</u> <u>on</u> <u>seismic</u> <u>data</u>.

Jones column 1 line 43 through column 3 line 34 discusses geologic modeling. Column 1 lines 63-64 recites that the process commonly uses <u>three</u> <u>data</u> <u>types,</u> <u>none</u> <u>of</u> <u>which</u> <u>are</u> <u>seismic</u> <u>data</u>. (The three data types are rock property data from wells; structural surfaces or horizons; and stratographic surfaces; the last two are in the form of 2D computer grids or meshes. The rock property data typically comprises strings of information along a borehole. The structural surfaces or horizons are generated through well known procedures by one of several commercially available software programs and limit the top and base of the model and define the volume being modeled as well as boundaries of zones within the model. The stratographic surface grids define geologic correlation across a model within each zone. They indicate those portions of the model that correlate laterally block to block or well to block. They may have been used to define the blocks.)

Jones continues to discuss the geologic modeling processes using the above three types of (<u>non-seismic</u>) data to assign values of rock properties of interest to blocks within the geologic model. See column 2 line 46 and following. (The assignment of a rock property to a block is a three step process. The X, Y, Z coordinates relative to stratographic surfaces are determined. Well data points in the near neighborhood of the block are located and correlated to the block being modeled. The value or rock property is calculated. One method used to calculate the rock property is a geostatistical method. See column 3 line 5 and following. This method takes into account the distance from the well and the continuity of the rock property. The three dimensional continuity of a rock property may be captured by a variogram. Deterministic geostatistical methods such as kriging may also be used. See column 3 line 35 and following. These are averaging methods that assign weights to data as a function of distance and a variogram model. Probabilistic geostatistical methods such as sequential Gaussian simulation and sequential indicator simulation could also be used. They produce geologic models that reproduce the continuity specified in the variogram model. Since the order in which the blocks are estimated affect a block property assignment, a 3D random path is typically used.)

Clearly Jones, above, in column 1 line 5 through column 3 line 34, does <u>not</u> teach geostatiscal variogram modeling <u>of</u> <u>seismic</u> <u>data,</u> or any use of such modeling. No lateral trends are computed <u>from</u>

seismic data, to be used, for instance, in interpolating scale factors or RMS velocites derived from seismic data.

Columns 14-16 do not correct the above deficiencies. Columns 14-16 deal with data preparation and initialization, and in general the steps 206 through steps 220 of Jones' Figure 5A.

Column 14 begins with pointing out that Jones' invention is primarily focused upon building a geological model such that synthetic seismic traces generated from the model match observed seismic traces. Since this seismic trace comparison alone is usually not adequate to generate a "reasonable" geologic model, additional geologic and geophysical criteria are supplied, such as spacial continuity of lithofacies and porosity, frequency distributions of lithofacies and porosity, and calibration-derived seismically based properties computed over seismic-time intervals. (Whatever "calibration derived seismically based properties computed over seismic time intervals" might be, it is not taught or suggested that it relates to lateral trends of seismically derived velocities or RMS velocities computed through geostatistical variogram modeling.) In the following column 14 Table 1 of useful objective-function components, note that all of the variograms apply to the "geological" components. No variogram modeling applies to the "geophysical" components, under which seismic data falls.

In column 15 second paragraph, Jones discusses the value of lateral variograms of lithofacies and porosity, geologic components for controlling lateral continuity of synthetic seismic traces, which are asserted to carry no direct information regarding lateral continuity themselves. In a paragraph in column 15 Jones discusses how lateral variograms of lithofacies and porosity can carry information into blocks having no observed seismic trace. In the bottom paragraph on column 15 Jones teaches that lithofacies and porosities are used to estimate acoustic velocity and bulk density, (not seismic data.)

Column 16 discusses the importance of considering the fluid content in a block as well as the lithofacies and porosity. The following portions in column 16 deal with creating the synthetic seismic traces.

Jones columns 14-16 thus do not teach "trend fitting," or computing lateral trends of RMS velocity from seismic data by geostatistical variogram modeling, or interpolation as a function of said lateral trends.

<div align="center">Claim 2</div>

Re claim 2, applicant recites constructing a geologically plausible velocity model from seismic data and variogram modeling of the interval velocities and trend fitting the velocities using the variogram model. Clearly Jones columns 16-19 do not so teach or suggest. Jones does not teach variogram modeling of seismic data to develop lateral trends and/or the use of such lateral trends. Jones does not teach constructing a geologically plausible velocity model from seismic data. Jones does not teach variogram modeling of resulting interval velocities. Jones does not teach trend fitting velocities using the aforesaid variogram modeling. Columns 17-19 do not correct the deficiencies of Jones's columns 14-16,

discussed above. Jones's columns 17-19 complete Jones' discussion of the initialization process prior to the beginning of the optimization program. The synthetic seismic trace is completed and statistics are calculated in regard to the degree of the agreement of the synthetic trace with observed traces. A weighting system is adopted. Columns 17 -19 of Jones do not teach computing lateral trends of RMS velocities derived from seismic data by geostatistical variogram modeling and/or interpolating with these lateral trends.

<div align="center">Other Independent Claims</div>

Considering also independent claims 22, 25, 28 and 33 clearly Jones also does not teach or suggest the application of geostatistical interpolation to velocity functions where the geostatistical interpolations are a function of lateral velocity trends developed from seismic data. Jones does not teach or suggest a variogram model of lateral velocity trends and geostatistically interpolating wherein the geostatistical interpolations are a function of the said variogram model. Jones does not teach or suggest generating lateral velocity trends and the interpolation of scale factors and velocity function as a function of the lateral velocity trends, the lateral velocity trends being generated from seismic data.

Summary re "Trend Fitting" Element of Instant Claims – All independent Claims

Jones and applicant prepare models by combining soft seismic data and hard well data and geologic data. As Jones teaches, column 4 line 60 and following, this was not new itself. Importantly, Jones and applicant combine the data in different ways to achieve different results and different benefits. Jones does not teach the use of seismic data for trend fitting, or to generate velocities, or variogram modeling of seismic data to develop lateral trends. In distinction, Jones uses an observed - synthetic seismic data comparison as a check upon the accuracy of his continuously iterated geologic model. (Jones starts with an initial model based on geology. Jones perturbs the model randomly and uses a synthetic versus observed seismic data comprises as one check upon whether the purturbation is an improvement.) Applicant, to the contrary, relies on the seismic data itself, combined with well data and geologic information, to generate the velocity model. The seismic data is the source of "lateral trends."

<div align="center">"Migrating" Element</div>

Applicant's independent claims, 1, 2, 28 and 33 contain an element reciting time and/or depth "migration" of seismic data. Claim 22 recites a velocity model for use in time migration of seismic data and claim 25 recites a method for developing a velocity model for use in migrating seismic data.

Jones mentions "migration" once, in the definition of seismic data, column 10 line 33. Jones does not teach migrating seismic data in the process of generating an improved geologic model. (It is conceivable that Jones's "seismic data" has already been migrated. Jones does not say.) Clearly, however, Jones does not teach a method for developing a velocity model for use in "migrating" seismic data, or a velocity model for use in the time migration of seismic data, as per claims 25 and 22. Clearly

Jones does not teach the steps of curved ray prestack time migration and/or prestack migrating and/or applying curved rate time migration and/or depth migrating, as per elements of claims 1, 2, 28 and 33.

"Scale Factor" and "Editing Seismic Data"

Similarly to the above comments, Jones does not teach or suggest a scale factor as disclosed in applicant's claims 1, 2/17, 22, 25, 28 and 33/35 and/or "editing" of seismic data as disclosed in claims 1, 1/3, 22/23, 25/26 and 28/29. In regard to the editing, the Examiner cites Jones column 3 lines 25 - 46. But as discussed above in depth, Jones column 3 lines line 25-46 relate to dealing with rock and geologic data, not seismic data.

In regard to the "scale factor," element of the claim the Examiner refers generally to Jones columns 14-19. Applicant has reviewed Jones columns 14 through 19 and finds no reference to a scale factor. Applicant finds no reference to preparing a scale factor from hard well data and soft seismic data. Jones does not teach or suggest, in columns 14-19, geostatistical interpolation of at least one scale factor with seismic soft data velocity functions, where that at least one scale factor is a function of well data. Jones columns 14-19 do not teach or suggest developing a set of scale factors for each of a plurality of hard data sources, each scale factor relating a hard data velocity function and a seismic data velocity function. Jones does not teach or suggest, columns 14-19, creating at least two sets of scale factors, each set associated with the source of well data and each scale factor being a function of a well data velocity function and a seismic velocity function.

In general, as discussed in depth above, Jones columns 14-19 address Jones data preparation and initialization, prior to beginning the optimization process. Jones's Figure 5A covers these steps 202 through 222. Jones' Figure 5A, illustrating steps 202 through 222, does not teach or suggest computation of a scale factor.

Again, a prima facie case has not been made in regard to the migrating element, the editing element or the scale factor element.

Reconsideration and further examination is respectfully requested.

Applicants have made a diligent effort to place the claims in condition for allowance. However, should there remain unresolved issues that require adverse action, it is respectfully requested that the Examiner telephone Sue Z. Shaper, Applicants' Attorney at 713 550 5710 so that such issues may be resolved as expeditiously as possible.

For these reasons, and in view of the above amendments, this application is now considered to be in condition for allowance and such action is earnestly solicited.

Respectfully Submitted,

6/25/8
Date

Sue Z. Shaper

Attorney/Agent for Applicant(s)
Reg. No. 31663

Sue Z. Shaper
1800 West Loop South, Suite 1450
Houston, Texas 77027
Tel. 713 550 5710